

## CLAIMS

What is claimed is:

1. A purification system comprising:  
a substrate;  
a layered catalytic coating including a first layer of one of metal/titanium dioxide and metal compound/titanium dioxide applied on said substrate and a second layer of one of titanium dioxide and metal compound/titanium dioxide applied on said first layer.
2. The purification system as recited in claim 1 wherein said first layer is gold on titanium dioxide and catalytically oxidizes carbon monoxide to carbon dioxide and water.
3. The purification system as recited in claim 1 wherein said first layer is platinum/titanium dioxide and catalytically oxidizes low polarity organic compounds to carbon dioxide and water.
4. The purification system as recited in claim 3 wherein said first layer includes platinum on titanium dioxide, and said platinum has an increased affinity for said low polarity organic compounds, said low polarity organic compounds adsorb onto said platinum, and said hydroxyl radicals oxidize said low polarity organic compounds to carbon dioxide.
5. The purification system as recited in claim 1 wherein said first layer is manganese oxide/titanium dioxide and decomposes ozone.
6. The purification system as recited in claim 5 wherein said first layer includes manganese oxide on titanium dioxide, and said manganese oxide lowers an energy barrier of decomposition of said ozone to decompose said ozone to molecular oxygen.

7. The purification system as recited in claim 1 further including a light source to activate said layered catalytic coating, and said layered catalytic coating oxidizes contaminants in an air flow that are adsorbed onto said layered catalytic coating when activated by said light source.
8. The purification system as recited in claim 7 wherein said light source is an ultraviolet light source.
9. The purification system as recited in claim 7 wherein photons from said light source are absorbed by said layered catalytic coating, forming a reactive hydroxyl radical that oxidizes said contaminant in the presence of oxygen and water, and said reactive hydroxyl radical oxidizes said contaminants to water and carbon dioxide.
10. The purification system as recited in claim 7 wherein said contaminants are one of a volatile organic compound and a semi-volatile organic compound including at least one of formaldehyde, toluene, propanal, butene, acetaldehyde, aldehyde, ketone, alcohol, aromatic, alkene, and alkane.
11. The purification system as recited in claim 10 wherein said volatile organic compounds have boiling point less than 200°C.
12. The purification system as recited in claim 10 wherein said semi-volatile organic compounds have boiling point equal to or greater than 200°C.

13. The purification system as recited in claim 1 wherein said second layer is metal compound/titanium dioxide including metal oxide on titanium dioxide, and said metal oxide is at least one of  $\text{WO}_3$ ,  $\text{ZnO}$ ,  $\text{SrTiO}_3$ ,  $\text{Fe}_2\text{O}_3$ ,  $\text{V}_2\text{O}_5$ ,  $\text{SnO}_2$ ,  $\text{FeTiO}_3$ ,  $\text{PbO}$ ,  $\text{Co}_3\text{O}_4$ ,  $\text{NiO}$ ,  $\text{CeO}_2$ ,  $\text{CuO}$ ,  $\text{SiO}_2$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{Mn}_x\text{O}_2$ ,  $\text{Cr}_2\text{O}_3$ , and  $\text{ZrO}_2$ .

14. The purification system as recited in claim 1 wherein said second layer is porous.

15. The purification system as recited in claim 1 wherein said second layer is partially transparent to ultraviolet light.

16. The purification system as recited in claim 1 wherein the purification system purifies air.

17. The purification system as recited in claim 1 wherein said first layer is said metal compound/titanium dioxide including metal compound on titanium dioxide and said metal compound is metal oxide.

18. The purification system as recited in claim 1 wherein said second layer is metal compound/titanium dioxide including metal compound on titanium dioxide, and said metal compound is metal oxide.

19. The purification system as recited in claim 1 further including a surface of said substrate, and wherein said first layer is on a portion of said surface of said substrate and said second layer is on a different portion of said surface of said substrate.

20. A fluid purification system comprising:
- a container having an inlet and an outlet;
  - a porous substrate inside said container;
  - a device for drawing a fluid into said container through said inlet, flowing said fluid through said porous substrate, and expelling said fluid out of said container through said outlet;
  - a layered catalytic coating including a first layer of one of metal/titanium dioxide and metal oxide/titanium dioxide applied on said substrate and a second layer of one of titanium dioxide and metal oxide/titanium dioxide applied on said first layer; and
  - an ultraviolet light source to activate said catalytic coating, and photons from said ultraviolet light source are absorbed by said metal/titanium dioxide catalytic coating to form a reactive hydroxyl radical, and said reactive hydroxyl radical oxidizes contaminants in said fluid that are adsorbed onto said metal/titanium dioxide catalytic coating when activated by said light ultraviolet light source to water and carbon dioxide in the presence of water and oxygen.

21. A fluid purification system comprising:  
a first substrate having a first coating of one of metal/titanium dioxide and metal oxide/titanium dioxide; and  
a second substrate having a second coating of one of titanium dioxide and metal compound/titanium dioxide.
22. The fluid purification system as recited in claim 21 wherein said first coating is gold/titanium dioxide and said second coating is metal oxide doped titanium dioxide.
23. The fluid purification system as recited in claim 22 wherein a metal oxide of said metal oxide doped titanium dioxide is at least one of  $\text{WO}_3$ ,  $\text{ZnO}$ ,  $\text{SrTiO}_3$ ,  $\text{Fe}_2\text{O}_3$ ,  $\text{V}_2\text{O}_5$ ,  $\text{SnO}_2$ ,  $\text{FeTiO}_3$ ,  $\text{PbO}$ ,  $\text{Co}_3\text{O}_4$ ,  $\text{NiO}$ ,  $\text{CeO}_2$ ,  $\text{CuO}$ ,  $\text{SiO}_2$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{Mn}_x\text{O}_2$ ,  $\text{Cr}_2\text{O}_3$ , and  $\text{ZrO}_2$
24. The fluid purification system as recited in claim 22 wherein said first substrate is proximate to an inlet of the air purification system and said second substrate is distal to said inlet of said air purification system.
25. The fluid purification system as recited in claim 21 wherein said first coating is manganese oxide/titanium dioxide and said second coating is metal oxide doped titanium dioxide.
26. The fluid purification system as recited in claim 25 wherein a metal oxide of said metal oxide doped titanium dioxide is at least one of  $\text{WO}_3$ ,  $\text{ZnO}$ ,  $\text{SrTiO}_3$ ,  $\text{Fe}_2\text{O}_3$ ,  $\text{V}_2\text{O}_5$ ,  $\text{SnO}_2$ ,  $\text{FeTiO}_3$ ,  $\text{PbO}$ ,  $\text{Co}_3\text{O}_4$ ,  $\text{NiO}$ ,  $\text{CeO}_2$ ,  $\text{CuO}$ ,  $\text{SiO}_2$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{Mn}_x\text{O}_2$ ,  $\text{Cr}_2\text{O}_3$ , and  $\text{ZrO}_2$

27. The fluid purification system as recited in claim 25 wherein said second substrate is proximate to an inlet of the air purification system and said first substrate is distal to said inlet of said air purification system.

28. The fluid purification system as recited in claim 21 wherein said first substrate is adjacent to said second substrate.

29. The fluid purification system as recited in claim 28 wherein said first substrate is secured to said second substrate.

30. The fluid purification system as recited in claim 29 wherein said first substrate is secured to said second substrate by one of an adhesive or an attachment mechanism.

31. The fluid purification system as recited in claim 28 further including a third substrate having a third coating of one of titanium dioxide, metal/titanium dioxide and metal compound/titanium dioxide and a light source, and first substrate and said second substrate are located on a first side of said light source and said third substrate is located on an opposing second side of said light source.

32. The fluid purification system as recited in claim 31 further including a third substrate having a third coating of one of titanium dioxide, metal/titanium dioxide and metal compound/titanium dioxide and a light source, and first substrate and said second substrate are located on a first side of said light source and said third substrate is located on an opposing second side of said light source.

33. A method of purification comprising the steps of:

applying a layered catalytic coating including a first layer of one of metal/titanium coating and metal oxide/titanium dioxide applied on said substrate and a second layer of one of titanium dioxide and metal oxide/titanium dioxide applied on said first layer;

activating said layered catalytic coating;

forming a reactive hydroxyl radical;

adsorbing contaminants in an air flow onto said layered catalytic coating; and

oxidizing said contaminants with said hydroxyl radical.